

# Gem Drive Safe Torque Off Manual

gb



## Actuator

INFRANOR®

## WARNING

This is a general manual describing a series of servo drives having output capability suitable for driving AC brushless sinusoidal servo motors.

Please [see GD1 User Guide](#) for the operation of the drive (commissioning, configuration, ...).

**Instructions for storage, use after storage, commissioning as well as all technical details require the MANDATORY reading of the manual before getting the drives operational.**

**Maintenance procedures should be attempted only by highly skilled technicians having good knowledge of electronics and servo systems with variable speed (EN 60204-1 standard) and using proper test equipment.**

The conformity with the standards and the "CE" approval is only valid if the items are installed according to the recommendations of the drive manuals. Connections are the user's responsibility if recommendations and drawings requirements are not met.



### CAUTION

Any contact with electrical parts, even after power down, may involve physical damage. Wait for at least 10 minutes after power down before handling the drives (a residual voltage of several hundreds of volts may remain during a few minutes).



### ESD INFORMATION (ElectroStatic Discharge)

INFRANOR drives are conceived to be best protected against electrostatic discharges. However, some components are particularly sensitive and may be damaged if the drives are not properly stored and handled.

#### STORAGE

- The drives must be stored in their original package.
- When taken out of their package, they must be stored positioned on one of their flat metal surfaces and on a dissipating or electrostatically neutral support.
- Avoid any contact between the drive connectors and material with electrostatic potential (plastic film, polyester, carpet ...).

#### HANDLING

- If no protection equipment is available (dissipating shoes or bracelets), the drives must be handled via their metal housing.
- Never get in contact with the connectors.



### ELIMINATION

In order to comply with the 2002/96/EC directive of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE), all INFRANOR devices have got a sticker symbolizing a crossed-out wheeled dustbin as shown in Appendix IV of the 2002/96/EC Directive.

This symbol indicates that INFRANOR devices must be eliminated by selective disposal and not with standard waste.

INFRANOR does not assume any responsibility for any physical or material damage due to improper handling or wrong descriptions of the ordered items.

Any intervention on the items, which is not specified in the manual, will immediately cancel the warranty.

INFRANOR reserves the right to change any information contained in this manual without notice.

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Issue: 1.1

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## Chapter 1 – General description |

**Safe Torque Off (STO)** definition according to the EN 61800-5-2 standard:

"Power, that can cause the rotation of a motor (or displacement in the case of a linear motor), is not applied to the motor. The drive will not provide energy to the motor which can generate torque (or force in the case of a linear motor)".

The STO function corresponds to an uncontrolled stopping in accordance with the stop category 0 of the EN 60204-1 standard.

The STO function may be used where power removal is required to prevent an unexpected start-up.

In circumstances where external influences (with vertical loads for example) are present, additional measures (mechanical brakes for example) may be necessary to prevent any hazard.

The standard output of the drive must not be considered as a safe output. When using a mechanical brake, it will be mandatory to introduce a safe contact from an external device in the brake actuation line.

The STO function cannot be considered as a safe insulation device for the motor. It does not prevent from any voltage on the motor terminal block.

**The integrated STO function fulfills the EN ISO 13849-1:2006 category 3 PLd requirements.**

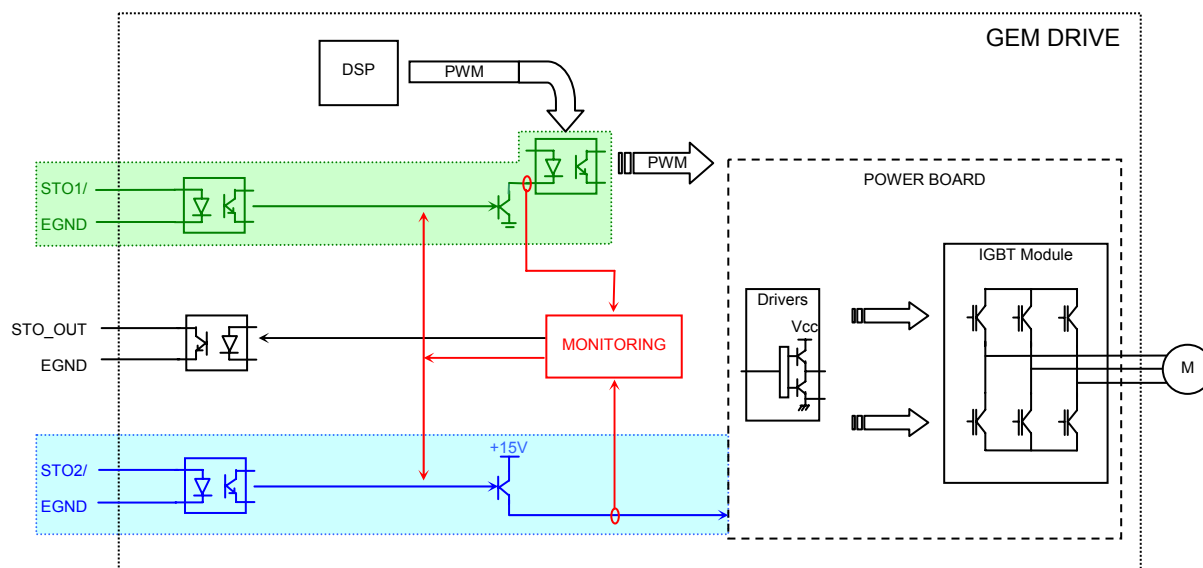
**PLd corresponds to SIL2, according to "Table 4 - Relationship between PL and SIL" of 13849-1 standard.**

## Chapter 2 – Specifications

### 2.1 – FUNCTIONAL DIAGRAM

The "Safe Torque Off" function allows to keep the motor shaft free by avoiding the IGBT module commutation. This is achieved by means of two techniques:

- IGBT command supply removal,
- PWM removal.



Different parts of the functional diagram are described below:

- The green part is the first channel of the safety function. PWM signals are disabled by inhibiting the optocouplers commutation.
- The blue part is the second channel of the safety function. IGBT gate signals are disabled by the power supply shut down.
- The red part is the monitoring function which detects faults by comparing the two channel outputs. If a fault is detected this function locks both channels in safe state.
- The black part is the functional part of the drive which is not used to achieve the safety function. STO\_OUT output is the state feedback to facilitate the function integration. This output is not safe. It only has an informative function.

### 2.2 – COMMAND SYSTEM CONCEPTION

#### 2.2.1 –SAFETY INSTRUCTIONS

The integration of the STO function must be the result of a risk analysis of the complete machine. All control components must comply with the requirements of this risk analysis.

Installing and commissioning of safety functions must be performed by skilled personnel only.

Short-circuit avoidance:

Install the drive in a control cabinet with a minimum IP54 protection.

Avoid control signals proximity. Any short-circuit between two control signals must be detected:

- the short circuit will either be detected by the circuit-breaking system (fuse for example); in this case, the voltage reference is grounded, and shielded pair cables must be used (shield is connected to the ground), or ribbon cable with all unused wires connected to the ground to prevent proximity with hot potential signals
- or a short-circuit detection device must be integrated.

Take care that, as the STO function performs the motor power removal without shutting down the power supply, electrical risks remain unchanged when the STO function is active or inactive.

In applications with vertical axes, additional measures (mechanical brake) may be necessary.

Refer to the EN13849-2 standard for any complementary information.

## 2.2.2 – STO CONNECTION

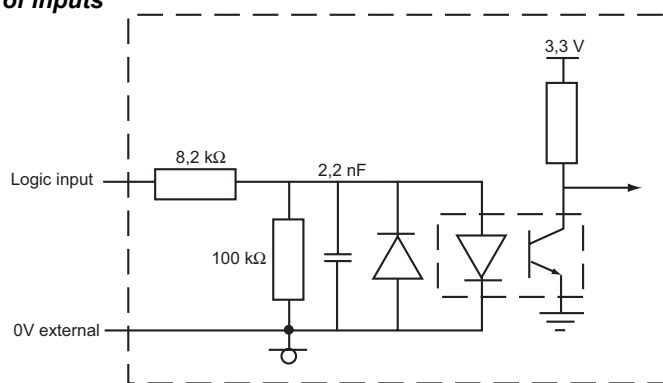
### 2.2.2.1 - X2 Connector

Weidmuller D 32 pins male  
Section: 0.25 mm<sup>2</sup> (AWG22)

X2 N°	SIGNAL	DESCRIPTION
19	+24V external	External 24 V supply, wired if the STO_OUT output is used
20	GND external	Voltage reference of the STO1/, STO2/ inputs, and STO_OUT output.
21	$\overline{STO1}$	Channel 1 input for the STO function inhibition High level releases the enabling
23	$\overline{STO2}$	Channel 2 input for the STO function inhibition High level releases the enabling
26	STO_OUT	Digital output for state feedback, non safe.

During the installation, take care to avoid proximity between any STO signal and high potential.

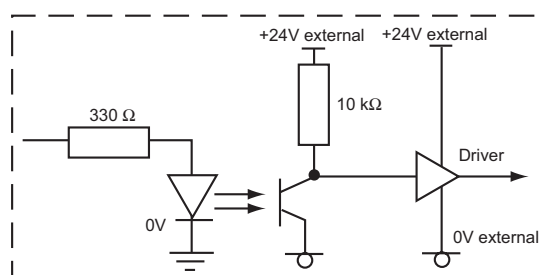
### 2.2.2.2 - Specifications of inputs







These optocoupled inputs operate in negative logic.

The input voltage corresponding to level 1 must be between 18 V and 30 V.

### 2.2.2.3 - Specifications of output



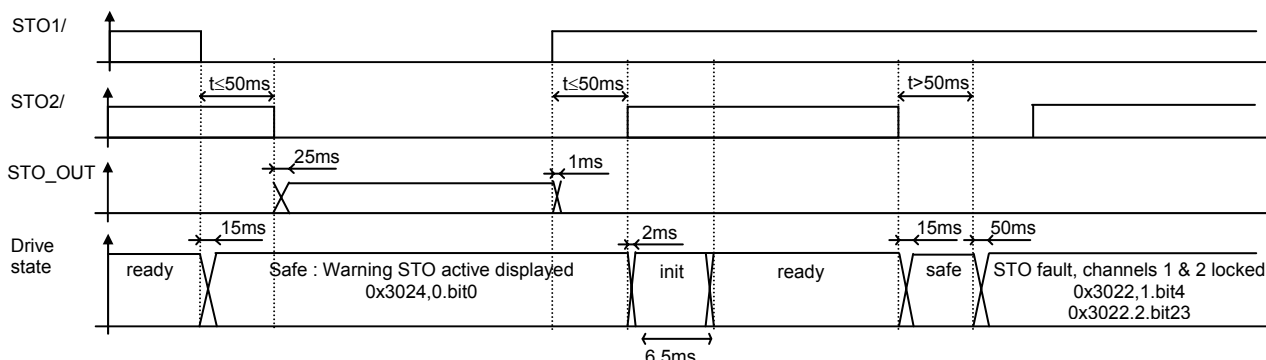
-  External supply +24 V (18 V < U < 30 V)
-  Maximum voltage drop: 2 V
-  Protection against overload
-  Available output current per output (mA)

Number of activated outputs / Cycle ratio (%)	100 %	70 %	50 %	30 %
2	200 mA	200 mA	200 mA	200 mA
4	100 mA	150 mA	200 mA	200 mA

### 2.2.3 – TIMINGS

The STO function has an activation / release response time of 15ms / 2ms max.

However, an additional delay of 6,5 ms after STO inputs are high is necessary before the enable/inhibit signal activation, as mentioned on the following chronogram:



A functional incoherence state between channels 1 and 2 is allowed during 50ms. The response time of the monitoring part is 100ms to 200ms.

If the monitoring part detects incoherence between channel 1 and 2, it locks both channels in the safe state. The STO fault cannot be reset. This state can only be exited by shutting down the 24V power supply. At this moment, the user must find and solve the problem that caused this fault state.

The STO function has two ways to check the state of the drive: the "STO\_OUT" digital output, and objects fieldbus (STO active warning, STO channel 1 & 2 errors). All these state feedback are provided for informative purpose and cannot be used as safe information.

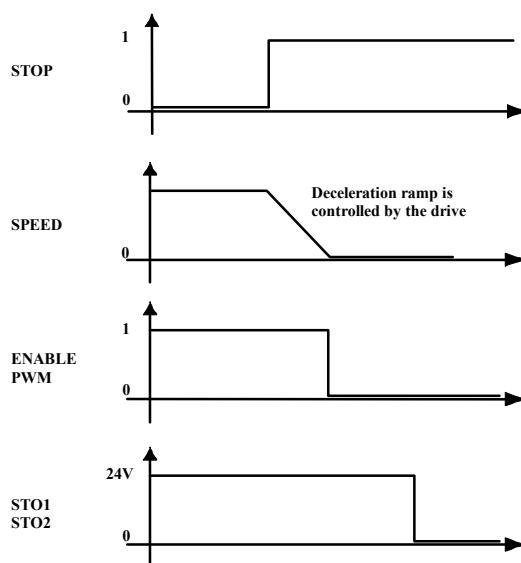


**Take care to automatic restart:** When the STO function is disabled, the restart of the machine should only be possible by an explicit demand to prevent unexpected automatic restart. Take care to this point when the user program manages the drive start/stop.

Used alone, the STO function corresponds to an uncontrolled stop in accordance with stop category 0 of the EN 60204-1 standard. So, this function is suitable to machines with low inertia or high resistive torque.

When using high inertia or low resistive torque machines, the user should initiate a controlled stop. To achieve a controlled stop in accordance with stop category 1 of the EN 60204-1 standard, the control system of the machine must generate the following sequences:

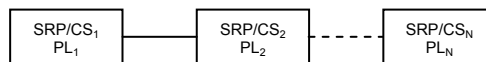
- Deceleration of the load by means of the drive control,
- When the load is at standstill or almost, disabling the PWM.
- Finally, activation of the STO function.



## 2.2.4 – PERFORMANCE LEVEL

The **Safe Torque Off** function fulfills **category 3 /PLd** <sup>(1)</sup> requirements of the EN ISO 13849-1:2006 standard. **PLd** corresponds to **SIL2** according to "Table 4 - Relationship between PL and SIL" of the EN ISO 13849-1:2006 standard.

To achieve overall PL by combining safety related parts in series, refer to §6.3 of 13849-1 standard:



PL <sub>LOW</sub>	N <sub>LOW</sub>	⇒	PL
a	>3	⇒	None, not allowed
	≤3	⇒	a
b	>2	⇒	a
	≤2	⇒	b
c	>2	⇒	b
	≤2	⇒	c
d	>3	⇒	c
	≤3	⇒	d
e	>3	⇒	d
	≤3	⇒	e
NOTE The values calculated for this look-up table are based on reliability values at the mid-point for each PL.			

<sup>(1)</sup> See attached attestation of conformity in chapter 4.

## 2.2.5 – PERIODIC INSPECTION ROUTINES

The well-working of the function needs to be checked at least once a year and during the validation of the machine safety functions.

The goal of this procedure is to verify that all subsystems of the safety function are operational. The command system must integrate a checking mode reserved to an operator aware of potential risks due to a bad operation of the safety system. It is highly recommended that the operator signs a register in order to sensitize him.

Step N°	Input		State		
	STO1/	STO2/	STO_OUT	Motor	Description
1	1	1	0	Powered	No fault is displayed.
2	0	0	1	Free	STO active warning is displayed.
3	1	1	0	Powered	No fault is displayed.
4	0	1	0	Free	STO fault is displayed.
5	1	1	0	Free	STO fault is displayed and must be unresetable.
6	X	X	X	X	Shut down of 24V power supply to reset STO fault

At each step, the operator must verify that the motor provides or not torque,

If the drive behavior is different from the one described in the table above, the drive must be replaced.

## 2.2.6 – RESIDUAL RISK

In case of short-circuit between two power transistors, there is a residual risk of motor shaft rotation that can reach:  $\frac{360^\circ}{2p}$  (2p: number of motor poles).



Take care of electrical risks, as the STO function performs the motor power removal without shutting down the power supply and there is no galvanic insulation.

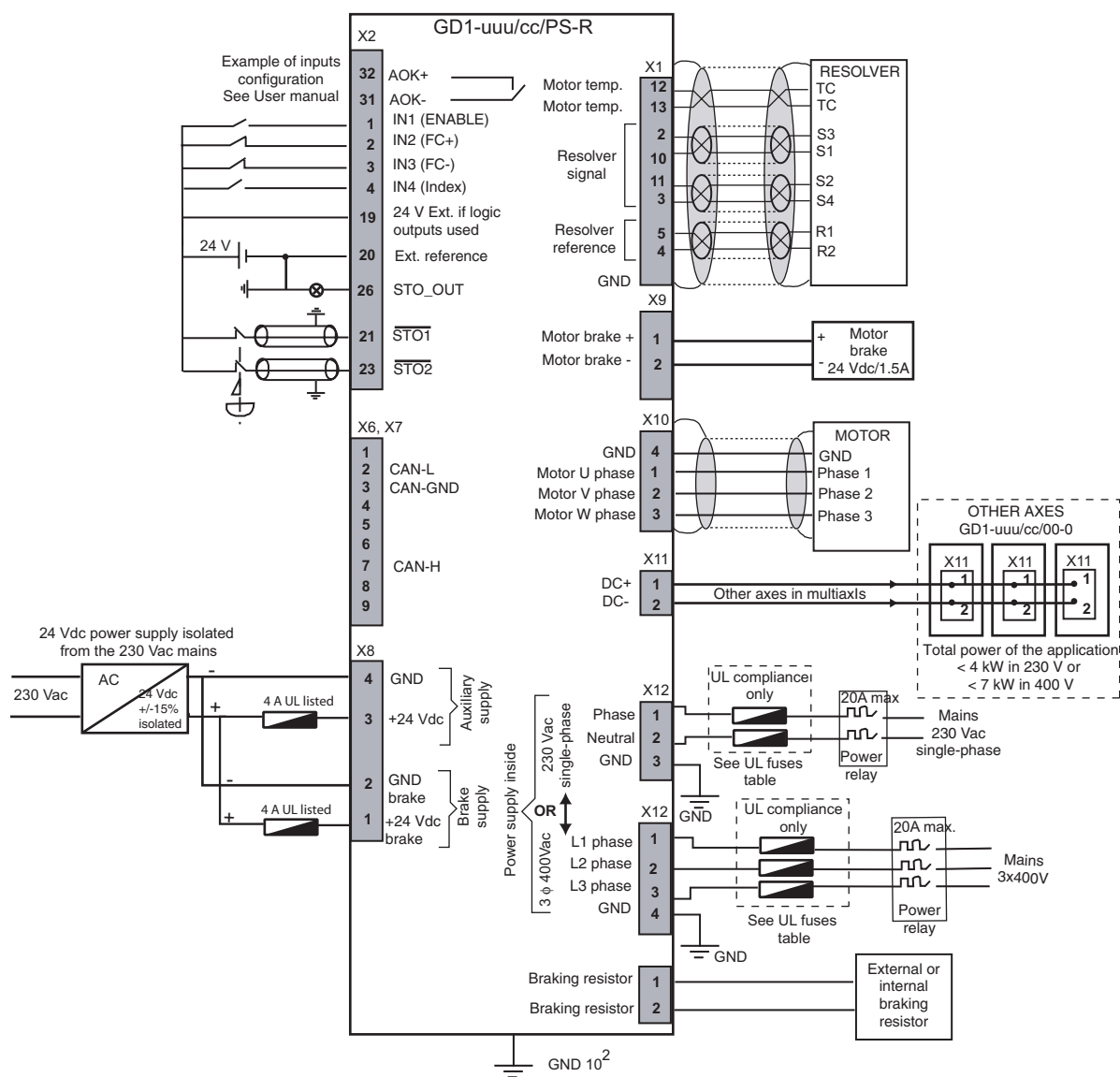


## Chapter 3 – Connection example

Following diagram examples are given to make the integration of the safety function easier. The integration of the STO function must be the result of a risk analysis of the complete machine.

### 3.1 – Example 1: Stop category 0 according to EN 60204-1 complying with EN13849-1 cat. 3

Low inertia axis application / high resistive torque

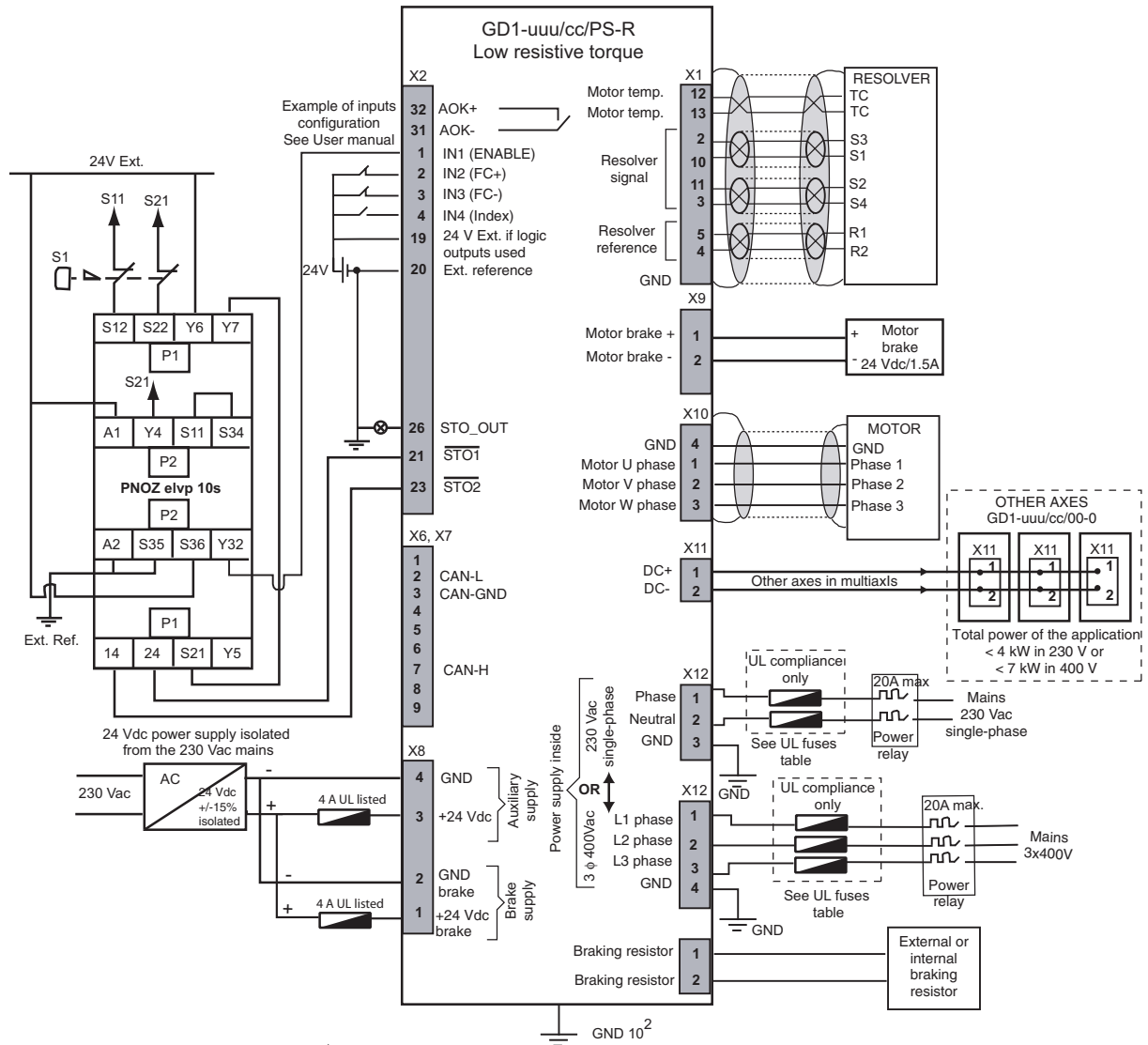


Please note that the motor control must be disabled before activating the STO function. In the example, the digital input IN1 (enable) is used to disable the PWM control. A light is wired with STO\_OUT output to inform the drive state.

### 3.2 – Example 2: Stop category 1 according to EN 60204-1 complying with EN13849-1 cat. 3

#### High inertia axis application / low resistive torque

In the following diagram, only the STO integration is safe. The deceleration ramp is not safe according to EN13849-1 because it uses a common drive function.



In the connection diagram example above, the PILZ safety relay orders the servodrive to decelerate by the ENABLE signal, and after a safety delay of 0.5 s, it activates the STO function of the drive. Note that the behavior of the servodrive on the ENABLE signal activation has to be setup in the appropriate mode (i.e. speed ramp deceleration) prior to any stop procedure.

In this example diagram, the user does not need to use shielded cables because the PILZ safety relay detects short-circuits.

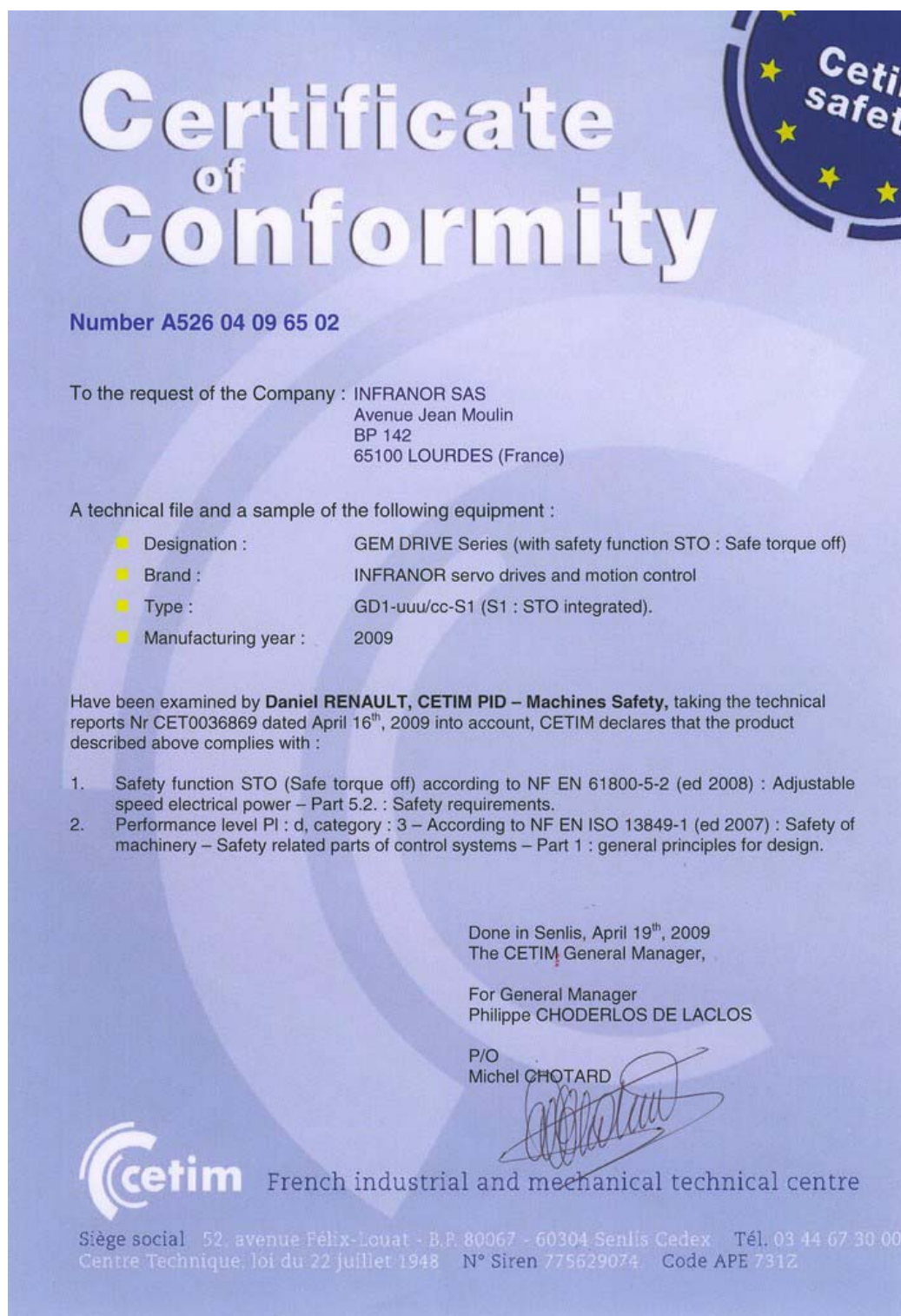
The output used to generate the Inhibit/Enable signal does not need to be a safety one because only the STO function is safe according to EN13849-1 category 3.

A light is wired with STO\_OUT output to inform the drive state.

## Chapter 4 – Appendix

### 4.1 – ATTESTATION OF CONFORMITY

After a deep analysis of the GD1 range, the CETIM (French Industrial and Mechanical Technical Center) third-party attests the compliance of the GD1 range with the EN954-1 and EN 13849-1 standards:



**Certificate of Conformity**

**Number A526 04 09 65 02**

To the request of the Company : INFRANOR SAS  
 Avenue Jean Moulin  
 BP 142  
 65100 LOURDES (France)

A technical file and a sample of the following equipment :

- Designation : GEM DRIVE Series (with safety function STO : Safe torque off)
- Brand : INFRANOR servo drives and motion control
- Type : GD1-uuu/cc-S1 (S1 : STO integrated).
- Manufacturing year : 2009


Have been examined by **Daniel RENAULT, CETIM PID – Machines Safety**, taking the technical reports Nr CET0036869 dated April 16<sup>th</sup>, 2009 into account, CETIM declares that the product described above complies with :

1. Safety function STO (Safe torque off) according to NF EN 61800-5-2 (ed 2008) : Adjustable speed electrical power – Part 5.2. : Safety requirements.
2. Performance level Pl : d, category : 3 – According to NF EN ISO 13849-1 (ed 2007) : Safety of machinery – Safety related parts of control systems – Part 1 : general principles for design.

Done in Senlis, April 19<sup>th</sup>, 2009  
 The CETIM General Manager,

For General Manager  
 Philippe CHODERLOS DE LACLOS

P/O  
 Michel CHOTARD

 **cetim** French industrial and mechanical technical centre

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 Centre Technique, loi du 22 juillet 1948 N° Siren 775629074 Code APE 731Z

## 4.2 – ORDER CODE

